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Oregon Agricultural College

Experiment Station

The Cranberry in Oregon

By

W. S. Brown.

The regular bulletins of the Station are sent free to the residents of Oregon who request them.

SUMMARY

1. The cultivated cranberry was first planted in Coos county, Oregon, in 1885 by Charles Dexter McFarlin, formerly a Cape Cod cranberry grower. The variety first planted was the McFarlin, one of the leading varieties of the Pacific Northwest today.

2. Acid-peaty soils, situated near a good deposit of sand, and preferably with an abundant water supply, are necessary for growing cranberries.

3. Careful clearing, ditching, leveling, diking, and sanding of new bogs are imperative if cost of management is to be kept at the minimum when the vines come into bearing.

4. Great care should be given in the planting to keep from mixing varieties and to avoid introducing insect pests.

5. Leading varieties are the McFarlin, Howes, Searles, Bennet Jumbo, Mammoth, and Centennial.

6. The cost of preparing the bog, planting, and bringing the vines into bearing will amount to $1,300 to $1,700 an acre in addition to the cost of the land.

7. Flooding to protect the bogs from insect pests and late spring frosts is not practiced as widely as it should be in Oregon. Water supply is usually sufficient to accomplish the ends desired if the bogs were properly leveled and diked into small areas.

8. Smudging is helpful in controlling light frosts but is not an entire protection against severe frosts and freezes.

9. Nicotine-sulfate sprays have been found effective against most of the cranberry insects.

10. Bordeaux mixture applied at the right time is successful in holding practically all the cranberry diseases under control.

11. The weed problem is usually a serious one upon which more experimental work is needed. Clean sand and careful pulling and mowing are the factors counted on for control.

12. Yields are naturally high in Oregon when bogs are given good management. Success in the cranberry business depends upon yields obtained and quality of the product more than upon other factors.

13. Keeping qualities of the fruit depend upon care in picking and grading. Rainy weather at picking time occasionally makes it difficult to dry berries rapidly, with the result that spoilage is heavy.

14. Most of the Oregon cranberries are marketed through a cooperative organization of growers.

The Cranberry in Oregon

By

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The cultivated cranberry (*Vaccinium macrocarpon*) is found growing in the cooler parts of the United States and in southern Canada from the Atlantic to the Pacific Ocean. Closely allied species, which, however, do not have any economic importance because the berries are smaller, are found in Europe and in parts of the United States. Thus far cranberry growing in Europe has been on an experimental basis only.

The cranberry was first cultivated near Cape Cod, Massachusetts, about 1820. It did not assume any commercial importance, however, until about 1850. Since that time the industry has steadily grown and has spread into several of the northern states where the climate and the soil requirements are suitable for the growth of cranberries. Different regions are producing as follows: Massachusetts 14,000 acres, New Jersey 13,000 acres, Wisconsin 2,000 acres, Washington 500 acres, Long Island, New York, 275 acres, Oregon 130 acres, other states about 200 acres, making a total of approximately 30,000 acres in the United States. In addition to this Nova Scotia is growing about 100 acres of bogs. It must not be forgotten that land devoted to reservoirs, sand banks, etc., must be credited to the industry. It is estimated that such land will amount to 40,000 acres more, making a total of some 70,000 acres of land needed for the industry.[1]

The cranberry industry brings in to the state of Massachusetts a gross annual return of $2,000,000 to $3,000,000, depending upon the season. It now occupies the place of the leading export crop of that state.[2]

As noted in the diaries of some of the explorers of the Lewis and Clark Expedition, cranberries were often purchased from the Indians after the expedition reached the lower part of the Columbia River. The early settlers on the Clatsop Plains found cranberries growing wild in that locality and picked them for their own use. They also sent them to California in the early days of land settlement there.

So far as we know, the first attempt at cultivation of the berry in Oregon was made by Charles Dexter McFarlin, a Cape Cod cranberry grower, who came to Coos county and set out vines which he brought from Massachusetts in 1885. Mr. McFarlin was very successful in this work, and took great pride in selecting the best strains of berries for propagating. The McFarlin cranberry is said to have been developed by him and his brother Thomas, who found it growing on their farm in Massachusetts (Fig. 1).

The first plantings in the state of Washington, on the north side of the Columbia River near its mouth, were made by a French gardener named A. Chebot, who planted 35 acres shortly after McFarlin started his plantings in Coos county, Oregon.[3] Chebot brought cuttings from bogs of the eastern part of the United States, and, unfortunately, brought in some of the worst insect pests and plant diseases at the same time. Later the development of the cranberry industry in the Northwest was held in check for a number of years by these insect pests and diseases, but after the special work done on the blackhead fire-worm in 1918-19,

and after experimentation on plant diseases done a few years later, the industry worked out remedies for most of its troubles, and is now in a thriving condition.

In 1911 C. N. Bennett and associates put out the first large bogs in Clatsop county.[4] At the present time there are about 100 acres in bearing in Clatsop county and approximately 30 acres in Coos county. Washington, as has been stated, has about 500 acres in good bearing.

The value of the cranberry crop in Oregon is approximately $40,000 to $50,000 a year, while that of Washington is approximately $175,000 to $225,000 a year. These values depend upon seasonal and market conditions.

Fig. 1. One of the bogs in Coos county. Most of the bogs in this county are relatively small.

There is considerable room for expansion of the industry in the Northwest as far as land is concerned. There are approximately 6,000 acres in Washington and 500 to 600 acres in Oregon, not in present plantings, that are suitable for cranberry growing.

Land, however, is not the only limiting factor in the growth of the cranberry business. Such matters as competition from cranberries grown in the eastern parts of the United States where labor is somewhat cheaper, competition with other fruits that occupy the market at the same time of year, distribution of the product to a large number of markets, and marketing organizations must be carefully considered by the man who is thinking about engaging in this enterprise.

Table I, taken from the Agricultural Abstract of the United States Department of Commerce, shows the status of the cranberry business in the United States for the past twelve years.

TABLE I. CRANBERRIES IN THE UNITED STATES

Year	1,000 acres harvested	Yields in 1,000 bbls.	Value in $1,000	Yield per acre in bbls.	Average price per bbl.
1914	22	697	2,766	31.7	3.97
1915	23	441	2,908	19.1	6.59
1916	26	471	3,449	18.0	7.32
1917	18	249	2,550	13.7	10.24
1918	25	352	3,791	13.9	10.77
1919	25	549	4,597	22.0	8.37
1920	25	449	5,514	18.0	12.28
1921	25	384	6,526	15.4	16.99
1922	25	560	5,702	22.4	10.18
1923	....	652	4,664	.....	7.15
1924	....	562	5,544	.....	9.86
1925*	28	530	5,238	19.0	9.88

*U. S. Department of Agriculture Yearbook, 1925.

According to careful estimates, the acreage on the Pacific Coast, as noted above, amounts to about 2½ percent of the total acreage in the United States, while the yield averages 25,000 barrels, or between 3 and 4 percent of the total yield. The population of the Pacific Coast states and their immediate neighbors is somewhat over seven million people or 6½ percent of the total of the United States. It appears from these figures that Pacific Coast cranberries have a marketing field large enough to warrant moderate and gradual expansion, provided the product is carefully graded, well advertised, and properly distributed and marketed.

On the other hand, it must not be forgotten by the prospective grower of cranberries that competition may become keener as time goes on and fruit must be produced at a cost which will enable him to meet such competition. Locations easily accessible to shipping points and, above all else, bogs which, if given good care, will yield abundantly berries of fine quality are the factors which will go very far toward insuring success. The man located on marginal cranberry land will probably have a harder time in the future than he has had up to the present.

DURATION OF THE BOG

Cranberry bogs in the state of Massachusetts are still in good condition and producing well at seventy-five years of age. The limit of profitable production does not depend so much upon age as upon the suitableness of the site and careful management. It is likely that these conditions will be found to hold true in Oregon as well as in the East.

CHOOSING PLANTING SITES

Locations. Oregon cranberries are grown on acid peat soils which are from 3 to 30 feet deep. Where other conditions are favorable, shallow peat and muck land may also be used to good advantage.

The land should have a very gradual slope to provide for water drainage. For covering the bogs, good, clean sand, free from weeds, should be easily accessible. It is best to have a good supply of water available all the year around, from either a running stream, a reservoir, or a pumping plant, though in southwestern Washington most of the bogs do not have water for flooding. In addition location near good shipping facilities is a great asset (Fig. 2).

Clearing and fitting the land. Some marsh-land is wooded with spruce, alder, willow, and other water-loving trees. Much small brush also grows between the trees. There is, however, much open land covered with weeds.

The first operation in fitting the bog consists in digging ditches to drain the land so that trees and brush can be removed. The trees and brush are then cut and burned as soon as they are dry enough. Due to the green stuff that grows in this climate the year around, there is very little danger from fire on the bogs. Sometimes fire may get into the peat if the water-table is low, but this is very infrequent.

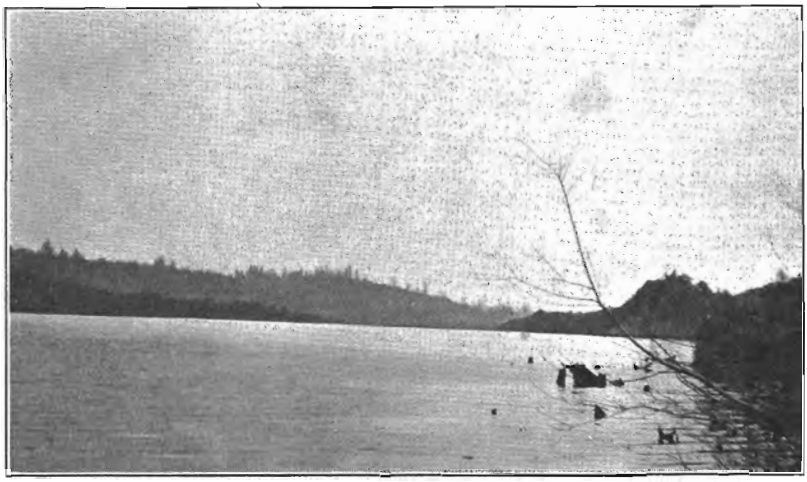


Fig. 2. A portion of Cullaby Lake, which furnishes most of the water supply for Clatsop county bogs.

Clearing of stumps and logs is done with donkey-engines and tractors supplemented with hand grubbing. The tractors must be of the track-laying type because the wheel types soon bury themselves in the soft peat. It is important that the stumps be removed to a depth of 12 to 16 inches below the surface and also that logs not too deeply submerged be dug up because when put under cultivation these bogs settle more or less and stumps not cut low enough gradually come to the surface and make the bogs very uneven and hard to handle (Fig. 3).

In the eastern part of the United States the land is often flooded for a couple of years to kill out all brush and tree growth. After that time the land can be drained and the brush and trees cut and burned. The great advantage of this treatment lies in the fact that all weeds on the bogs are thus killed.

After the brush, logs, and stumps have been removed the upper layer of soil containing roots and plants is cut loose by means of hand shovels. This process is called "scalping" or "turfing." On some eastern bogs scalping is accomplished by means of turfing plows and other spe-

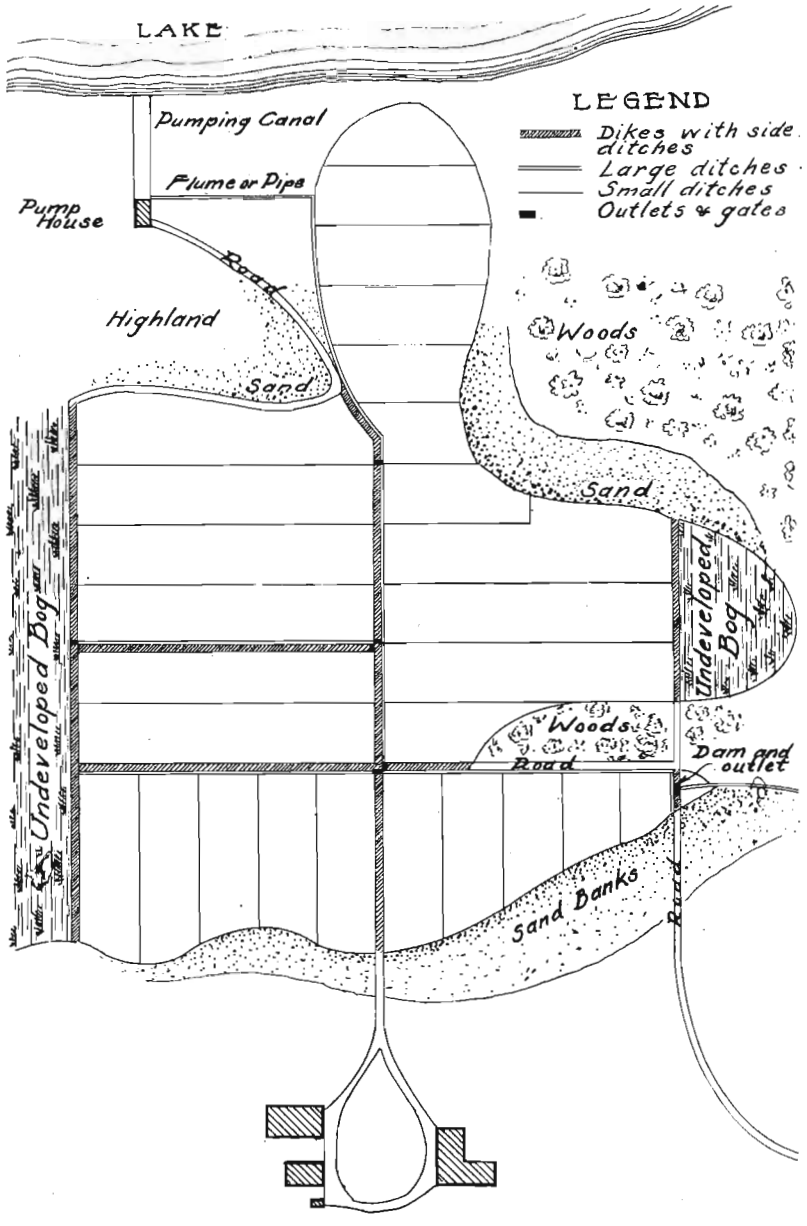
cial tools not well adapted to our conditions. Scalpings not needed for covering dikes are piled and burned on the dikes.

Ditches. After clearing has been done ditches should be dug around and through the bog at intervals, dividing it into sections. There should first be a main ditch running lengthwise of the bog where the greatest amount of water run-off would naturally come. The width and depth of this ditch should be large enough to accommodate all the water that may come down during freshets. When the bog is watered by pumping, main ditches do not need to be so large as when a stream flows through the bog.

Fig. 3. Spruce and other stumps, making clearing costly.

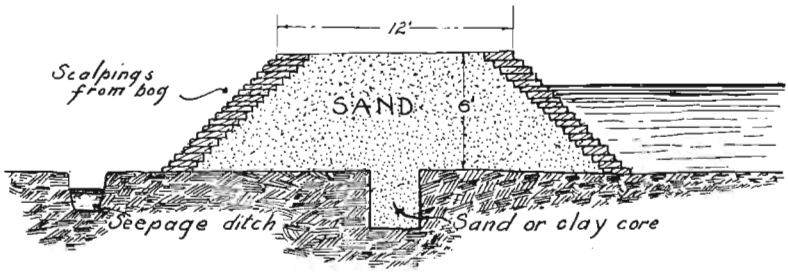
Side ditches are usually dug to a depth of about 3 feet, and are from 2 to 3 feet wide at the top, with sides having a moderate slope. Such ditches should be dug on the borders of the bog and should run from the border ditches across the bog. The distance apart these drainage ditches are placed will depend very largely upon the depth of the peat. Deep, coarse peat will drain much farther than thin, fine peat with a sandy subsoil. Under the former conditions, drainage ditches usually need not be placed closer than 150 feet apart. (Fig. 4.)

Dikes or dams. These are usually built by first cutting a ditch about 3 feet deep in the bog on the line in which the dike is to run. This ditch can then be filled with either sand or clay, the clay being somewhat more stable. The filling will act as a core and prevent washing of the dike. The dike is then built up at least a foot higher than high-water level at the time of flowing. This is to prevent waves from washing holes in the top of the dam. The bog should be ditched a few feet from the dike on

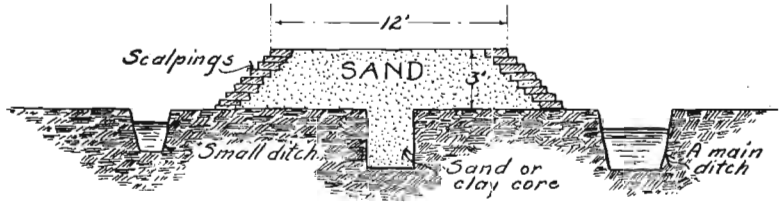


PLAN of DEVELOPED BOG

Fig. 4.



DAM at OUTLET for IMPOUNDING LARGE QUANTITIES of WATER



LOW DAM or DIKE for FLOODING

Fig. 5.

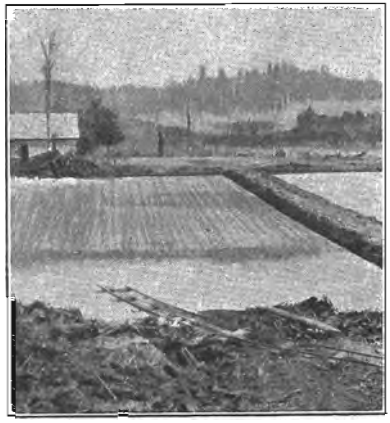


Fig. 6. Showing a dike, a ditch, a newly sanded bog on the right, and one season's growth on the left.

both sides. If the dam is to be used for a roadway it should be from 10 to 12 feet in width. If it is for a tramway, it may be somewhat narrower. It should be made largely of sand and covered with scalpings from the bog which will tend to keep the material from washing (Figs. 5 and 6).

Gates or flumes. Gates are made to regulate the flow of water through dikes and are generally of two types, the open top and the covered gate. The gates should be made by an experienced gate builder and may be constructed of wood or of concrete. Concrete is usually best except on very soft soils, where there is considerable danger of settling. In that case it is usually better to build a wooden gate, resting it upon sheet piling in order to prevent settling. Although the concrete gate costs more to construct, it is so much more durable than wood that the cost in the long run is less.

Open gates require sheet piling on both sides and beneath to prevent washing and undermining by muskrats. Closed or covered gates are stronger and seldom need piling under them. They should have wings built into the dike on either side to prevent tunneling by muskrats (Fig. 7).

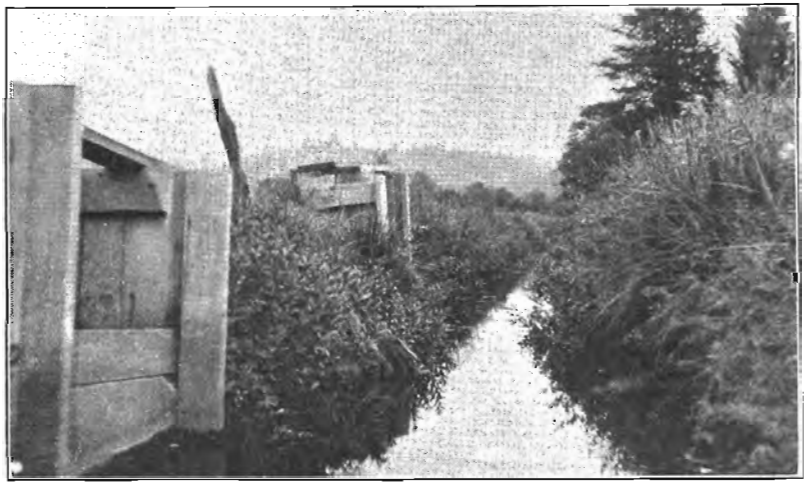
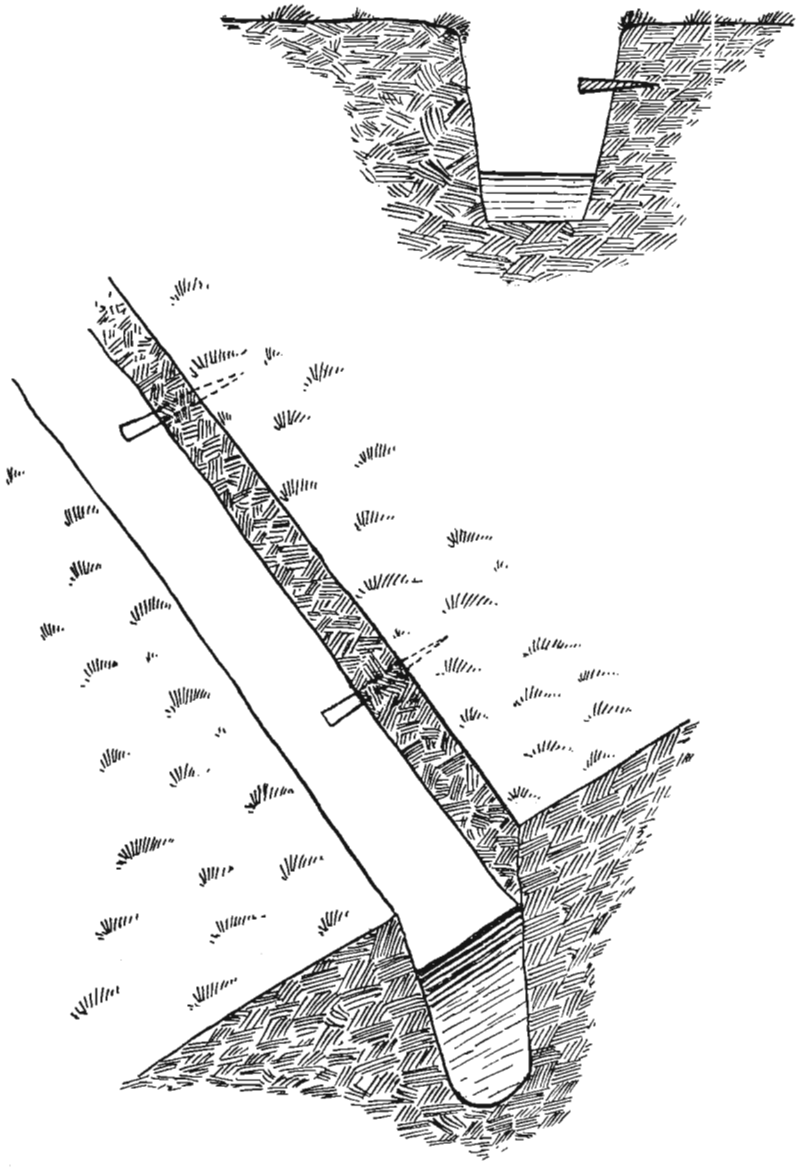


Fig. 7. The cheaper type of wooden gate.



METHOD of LEVELING by GUIDE STAKES

Fig. 8.

Grading. It is very important that the bog be leveled carefully. Water is used frequently for protection against frost. Some of the worst insect pests, such as the cranberry-girdler and the blackhead fire-worm, may also be controlled by flowing the water onto the bog at the right time. One of the greatest troubles being experienced by Oregon growers is the fact that there is considerable difference in level between the lower and upper portions of their bogs; further, many of the bogs are uneven, due to embedded stumps and logs. In some cases bogs are too large—such bogs should be divided into smaller tracts that can be leveled to the point where they can be flooded economically. Every precaution should be taken to make the bogs as level and as even as possible.

Leveling can be accomplished most easily by running the water into the ditches after damming the main outlet so that the water will back up to a dead level in the ditches. Small stakes are then set horizontally into the sides of the ditches at the surface of the water. The water may then be lowered or entirely drawn off from the ditch. These horizontal stakes should be supplemented by grade stakes set at different points on the bog by means of a surveyor's level. The material thrown out in digging ditches should be spread in holes and low places on the bogs. High spots may have the turf taken off and placed in depressions. Allowance must always be made for settling. Where fills run from 4 inches to 2 feet thick, from 1 to 6 inches additional soil must be placed on the grade. (Fig. 8.)

Sanding. After the bog has been made level, sand is scattered over its surface to a depth of 3 or 4 inches and leveled very carefully. The best sand for this purpose is medium to coarse in texture, and as free from weed seeds, loam, roots, etc., as possible. Very fine sand packs to such an extent that moss grows on it much faster than on coarse sand.

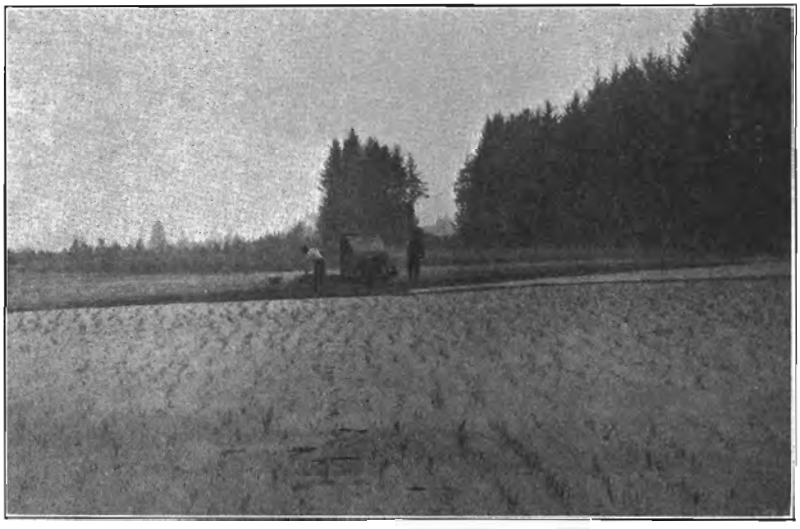


Fig. 9. An excellent method of sanding large areas.

In taking sand from the sand bank the top layer of soil containing the loam and weed seeds should be carefully removed.

Where the distance is relatively short, the sand may be transported by wheelbarrows run on planks, but for longer hauls dump cars, running on tracks which can easily be laid on the bog, are commonly used. These cars are pushed by hand, each car containing about 1¼ yards of sand (Fig. 9).

Sand helps to keep down weeds and moss. It gives a good medium for runner growth and therefore helps the plants get a better start. Sand does much to prevent frost because the heat absorbed by the sand in the daytime is radiated at night. It aids materially in the control of some serious cranberry insects, such as the cranberry-girdler. It promotes better drainage and aeration for the plants. On the other hand, sanding seems to encourage some plant diseases, though bogs well cared for and sprayed regularly need have little trouble in this respect.

PLANTING

Varieties. The McFarlin and Howes varieties are probably the most popular in Clatsop county. The Howes is a very late variety and consequently the picking may run into bad weather. It is a berry of good color and fine quality. The McFarlin, another berry of fine quality and maturing somewhat earlier than Howes, is an excellent yielder, but grows its vines so close to the ground and so short that it cannot be scooped without considerable loss and consequently is usually picked by hand. The Mammoth, a large, early, excellently colored berry, is recommended by some for a limited planting to go with the two leaders mentioned above. The Bennett Jumbo, or Oregon Jumbo, as it is sometimes called, is a good producer, but is susceptible to frost and does not keep as well as some other varieties. The Centennial is an excellent berry, of light color, but not so good a producer as the McFarlin, and is also susceptible to frost. The Searles, a variety with a notable reputation in some parts of the United States, is being tried out to some extent. Several other minor varieties have been tried. In Coos county, Southern Oregon, the leading variety is the Searles, followed by Bennett Jumbo and McFarlin. Several other eastern varieties have been tried out but are of little importance commercially in this region.

In planning the plantings it should be remembered that only one variety should be put in each flooding area. This is due to the fact that different varieties blossom and have to be picked at different times. Some portions of the bog may be infested with pests while other portions are free, and frost protection may be needed more on some portions of the bog than on others.

Selection of cuttings. The cuttings used for setting new bogs should be as true to name as possible. Mixtures of varieties often occur. Plants selected should be as free from insect pests and plant diseases as possible. If they are brought in from the eastern part of the United States every precaution should be taken by inspection at the points of origin and destination to avoid distribution of new pests and diseases.

The cuttings should preferably be taken from vines which have made a good growth during previous years. Good vines will average

about 700 to 1,000 pounds of cuttings to the acre. They are usually mowed off with a scythe or mowing-machine, and then packed in barrels or boxes when shipped some distance. The plants are laid in wet moss, and are ventilated by means of holes bored in the packing receptacle.

As most of the standard varieties are now grown in the Pacific Northwest it is possible to get cuttings here which are much fresher and which may be freer from pests than those shipped in from eastern sources.

Treatment of cuttings. Cuttings should usually be soaked a few days if they have been shipped from a considerable distance. This makes the tissue of the buds plumper, and the vines bend more easily in planting. The number of vines needed to the acre will depend upon the distance apart the hills are set, the number in the hills, and whether the material comes from old or new growth. The older growth is shorter and more vines are usually needed.

Planting distances. The average distance apart of the hills is about 12 by 12 inches. In some bogs they are planted considerably closer, while in others the distance may be from 16 to 18 inches apart. When planted 12 by 12 inches, from eight to ten thousand cuttings will be needed to the acre if two or three vines are planted to each hill. Closely planted vines soon shade the ground and put down weed growth. On the other hand, if set too closely, side runners are not encouraged to grow, the vines get tall and bushy, and do not, in the long run, produce as well as vines set far enough apart to produce strong runners.

Setting. Cuttings are planted from March 1 to June 15. The month of April is usually ideal for this work in Oregon. It is easier to plant if the cuttings are placed in fresh sand. After planting, the bog should be flooded for a day or two in order to wet up the sand thoroughly, and thus give the berries a good start.

In the process of setting, two or three vines are clumped together and forced down clear to the bottom of the sand by a wooden or an iron dibble. As these vines have been cut from 7 to 10 inches long, they will project after planting from 1 to 3 inches above ground. If they come above the ground further than this, they are blown about by the wind too much, and too large a leaf surface causes excess evaporation. One man can set about one-fourth of an acre a day, planting them 12 by 12 inches apart.

CARE OF YOUNG BOGS

The greatest job in handling the young bogs is to keep down the weeds. Experimental work is needed to determine better weed treatment. So far, most of the weeding is done by hand or by mowing. Flooding during winter and late spring will kill out upland weeds. On many of the Eastern bogs, resanding to the depth of half or three-quarters of an inch every few years at least is resorted to in order to assist in keeping down weeds and insects. So far, no resanding has been done on Oregon bogs. More experimental evidence is needed to show whether or not such treatment would be profitable.

Drainage should be carefully looked after during this period to develop strong root systems on the plants.

Bogs usually begin to produce the third year, but do not get into full bearing until the fifth year.

Costs of bringing into bearing. Such costs vary considerably, depending upon the nature of the clearing, size and shape of the bog, sand supply, number of stumps, water supply, and so on.

The approximate costs may be divided as follows:

Clearing and stumping	$100 to $150 an acre
Scalping and leveling	$250 to $300 an acre
Sanding	$150 to $200 an acre
Ditching and diking	$125 to $150 an acre
Plants and planting	$ 50 to $100 an acre
Weeding	$425 to $500 an acre
($75 to $100 a year for five years)	
Buildings, pumping plant, equipment, and incidentals	$200 to $300 an acre
Total cost	$1,300 to $1,700 an acre

This is in addition to the cost of the land.

MANAGEMENT OF THE BEARING BOG

Flooding for frosts and insects. Winter protection by flooding, which is given on all the eastern bogs, is usually unnecessary in the milder climate of Oregon.

Flooding the bogs in spring, summer, and autumn can be employed for the control of insect pests and the prevention of frost. To do this, it is necessary to have either a gravity supply of water or a good pumping apparatus which will cover the bogs with water in a few hours. For protection against lighter frosts it is not necessary to cover the bogs deeply; water standing at the surface is sufficient, because the radiation from the water will raise the temperature. On level bogs such shallow flooding can be employed at any time during the summer, even when the vines are blossoming, without danger to the plant. When the cranberry is in the blossom or "hook" stage, deep flooding is very likely to injure the blossom.

Flooding by gravity is usually the cheapest and most satisfactory arrangement when water can be impounded in reservoirs above the level of the bog. Many of the eastern bogs are handled in this way and the area needed for reservoirs is often as large as that used by the bogs. The Oregon bogs along the Coast are not usually supplied with water by gravity but are watered by pumping from reservoirs or lakes often having lower levels than the bogs.

For pumping, two types of pumps are in use, the propeller and the centrifugal types. For small lifts running up to 10 feet the propeller type is more efficient but for lifts above 10 feet the centrifugal type is as good or better, being decidedly superior on lifts above 14 feet.

The centrifugal pumps are of two kinds, the horizontal and the vertical. The latter is ordinarily used because it is submerged and

Fig. 10. A centrifugal pump used for flooding.

requires no priming. It may be set in a head gate, or in a flume, and it requires little attention (Fig. 10).

Smudging for frost protection. Observations by D. J. Crowley, Director of the Cranberry Branch Experiment Station of Southwestern Washington, indicate that[19] "serious injury is caused during blossoming time by a temperature of 32° F. and that a temperature of 28° F. will cause injury when berries are nearly mature. About 5% of our ripe berries freeze at a temperature of 25° F."

Mr. Crowley has observed that vines which have been frosted so heavily as to lose their crop are apt to grow much more vigorously that season and that these tall, matted vines are more likely to lose their crops from frost during subsequent years. Evidently the abnormally thick growth prevents the ground from absorbing the heat it should in the day time and frosts are more severe as a consequence.

Smudging or heating has been employed for some time to protect tree fruits from frost. For the protection of cranberries smudging has been tried in different places in recent years with only indifferent success. The chief point of difference between the fruit tree and the cranberry vine from the standpoint of fighting frost is that the latter lies close to the ground where the temperature often is 6° to 8° F. lower than that found three to four feet above ground. It is thus apparent that a great deal more heat will be required to warm the air clear to the ground than would be needed to save fruit three feet higher. Another difficulty lies in the fact that heat rises and does not spread out widely close to the ground.

Smudging may undoubtedly be of considerable benefit in light frosts, but with heavy frosts large batteries of smudge pots would be needed and firing would have to be started early in the night if protection were to be given. Even then when temperatures go down to 24° F. or below, as they have been known to, smudging would not afford complete protection.

Diesel oil is used for smudging, costing about 6c a gallon. The type of smudge pot generally used is the plain lard pail supplied with a cover and holding two and one-half gallons of oil. These pots cost about 42c each. Lighting is done by a torch fed with a mixture of gasoline and kerosene. The smudge oil is shipped in storage tanks from which it may be drawn off into a smaller tank on a truck or car and

distributed to the smudge pots by bringing these to the roadways on the dikes. The smudge pots are then placed on boards to keep them from burning the vines. From 70 to 125 pots an acre are needed, depending upon severity of frosts experienced. The cost of smudging will vary considerably with the number and severity of the frosts. (Fig. 11.)

One other aid to frost protection should not be overlooked, and that is the removal of brush and trees along the edge of bogs and along the waterways leading from bogs, in order to allow the cold air to run off as rapidly as possible. A very small barrier in the shape of brush may cause cold air to remain as a blanket over the bog.

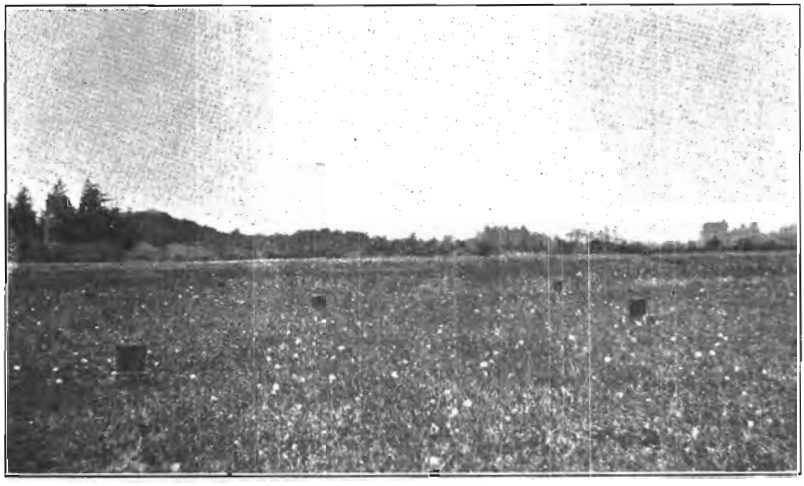


Fig. 11. Smudge pots ready for action. They rest on boards or boxes for protection to the plants. The blossoms shown are of the "false dandelion," one of the worst weeds.

INSECT CONTROL

(Reviewed by DON C. MOTE, Entomologist, Oregon Experiment Station)

There are a number of insects which do some damage to cranberry bogs. Several of these are of no economic importance, but there are three or four which have given considerable trouble and which have to be systematically held in check if cranberries are to be produced at a profit.

The chief offender in Oregon is the blackhead fire-worm. The cranberry-girdler may be put second in importance, while the strawberry-weevil is doing considerable damage in some sections. Another very troublesome insect which has arrived in the bogs of southwestern Washington, across the Columbia River from Clatsop county, is the cranberry fruit-worm. Undoubtedly this pest will become established in Oregon in the near future unless every precaution is used to keep it from crossing the Columbia River.

Blackhead fire-worm. The adult of the blackhead fire-worm (*Rhopobota naevana*)[3] is a small moth about one-quarter of an inch long. It is ra-

ther inconspicuous in color, having brownish and silver gray bars running diagonally to the front margin of the first pair of wings. It is naturally not a strong flier but may be carried by a strong wind for some little distance. The eggs are laid on the under side of the leaf. They are very small, being about 1/32 of an inch long, yellow in color. The larvae, which as a rule are hatching in large numbers by the latter part of May, are of reddish-brown color with black heads. They measure about a quarter of an inch in length and are very active. They web the leaves of the cranberries together with chewings and silk and, protected in this way, continue their feeding operations. Soon the plant takes on the appearance of having been burned, and the growth, not only for that season but for one or two seasons afterward, may be seriously injured.

The most common method of control in the Oregon bogs is to spray with a nicotine sulfate solution at a strength of one part nicotine sulfate to 500 parts of water (1½ lb. to 200 gal.) with 8 pounds of fish-oil soap used as a spreader to each 200 gallons of liquid. When nicotine sulfate is combined with an arsenate spray for the control of other insects also, the soap should not be added. To obtain good results, not less than 250 to 350 gallons of this solution, depending on depth of vines, should be used to the acre. Lightly infested vines are usually given three applications. Heavily infested vines require four.

According to D. J. Crowley control depends upon careful observation upon the part of the grower. He should look through the vines and stake them out where eggs are found, then watch until hatching begins in good numbers and spray. This should be followed about every ten days with subsequent sprayings until the end of the hatch of the first brood, which comes about the time of the "hook" stage of the cranberry plant. Thorough and timely spraying for the first brood will usually eliminate the need of spraying for the second brood. An additional spray when needed is put on to protect the berries and growing tips against late-hatching larvae that might do considerable damage to next year's crop as well as to the current season's crop. This spray will kill also many of the moths of the second brood which may be flying quite numerously at that time.

On the eastern bogs the most common and a very effective way of controlling this insect is by reflowing the bogs for periods of not less than 48 hours at a time. In Oregon this reflow should be made from the middle to the latter part of May when the larvae are practically full grown. Many of the Oregon bogs are not adapted to reflowing in the summer. For that reason the nicotine sulfate treatment will probably continue to be the most popular.

Cranberry-girdler (*Crambus hortuellus*).[5, 38] The adult is a small moth about ⅝ inch long, marked largely by silver gray coloring. Cranberry plants are injured by the larvae of the insect, beginning in the early part of summer and continuing until about mid-October. The worms feed upon the vines just above ground and do their damage by gradually girdling the vines, in extreme cases causing the leaves to drop off and the vine to be entirely killed. The larvae are difficult to find, because they hide themselves easily under the leaves and trash about the base of the plant. Their presence is usually first made known by the appearance of the vines. Vines are apt to be attacked in small areas at first, especially

on the drier portions of the bog. The method of control most often recommended is to flood the bog for one week not later than the first week in October and preferably during the latter part of September. To be effective this flooding must take place before the larvae spin their winter cocoons; after they are in the cocoons they seem to stand the water with immunity. In cases of heavy infestation it is advised to hold the winter flood waters on the bog until the early part of July. This will destroy the current season's crop but will free the bog entirely from the worm, and the buds for the next season's crop will have a chance to form during the latter part of the summer.

In some recent investigations by Beckwith, in New Jersey[18] it was found that flooding the bog for 24 hours during the early part of August was a very effective remedy in destroying all the larvae present. Fruit rots, which are naturally stimulated by flooding, were greatly reduced by spraying with bordeaux mixture applied before reflooding and immediately afterward. When the spray was done thoroughly fruit-rot did not become a serious factor on healthy vines. The berries on vines injured by the cranberry-girdler, however, were somewhat more subject to rot organisms than berries taken from healthy vines.

Where it is impractical for any reason to flood the bog in the summer or fall, a resanding may be resorted to, a measure which is fairly effective if very carefully done. This operation is usually performed during the fall or winter or early spring, but Dr. H. J. Franklin, director of the Massachusetts Cranberry Substation, advises a heavy resanding during the blossoming period, when the vines are in full bloom.[2] The sand should be distributed evenly at a depth of about 1½ inches. Franklin also reports that he has been able to control very large and serious infestations by spraying four times at three-day intervals with nicotine sulfate and soap during the period when the moths have their main emergence.

More experimental data are needed on the bogs of Oregon to determine which of these remedies suggested is the most useful. It is certain that the cranberry-girdler is becoming a serious pest in some bogs, and steps may have to be taken in a short time to control it more thoroughly.

Strawberry root weevil (*Otiorhynchus* sp.). This pest sometimes becomes troublesome on the cranberry bogs of Oregon. Until very recently no control measures had been developed for it. A poison bait named "Go-West" has been discovered, however, which very effectively handles this insect. This material is simply scattered over the bog, and is fed upon very voraciously by the beetles. Another effective bait may be made at home by using 5 pounds arsenate of lead (powdered), mixed with 95 pounds dried apple waste, ground through a meat chopper.

Cranberry fruit-worm (*Mineola vaccinii*).[3] This insect is one of the most serious found in Massachusetts cranberry bogs, though it does not seem to be very troublesome in New Jersey. It has made its appearance in southwestern Washington, and it may become a serious economic factor in the production of cranberries in Oregon. The larva of this insect attacks the fruit, the berry turns red prematurely and gradually shrivels on the vine. The fruit may hang on the vine until the following spring. The worm goes from one berry to another feeding on the seeds

and part of the pulp. Frequently the berries are fastened together by webs.

Flooding the bog for a period of two weeks after picking, beginning the flood by October 1, has been recommended for control. In case of heavy infestation it may be desirable to hold the winter flow late into the summer. The warm water kills the insect.

In Washington, according to Crowley, two or three sprayings of nicotine sulfate, 1 to 500, applied about 10 days apart, after the moths begin flying in numbers, has been found effective in holding this insect in check.

A very good general discussion of cranberry insects is found in the United States Department of Agriculture Farmers' Bulletin 860, entitled Cranberry Insect Problems and Suggestions for Solving Them[5] (Fig. 12).

Fig. 12. A high-powered spray outfit standing on a tramway switch.

CRANBERRY DISEASES

(Reviewed by H. P. BARSS, Plant Pathologist, Oregon Experiment Station.)

Many of the fungous troubles to which the cranberry is heir manifest themselves in storage, and are the results of infection in the field during the growing season.

Henry F. Bain, Assistant Pathologist of the Bureau of Plant Industry, United States Department of Agriculture, who was for three years stationed in Clatsop county, says that a survey of cranberries in the Pacific Northwest during 1922-1925 showed that practically all of the cranberry rots were found in the Northwest.[20] Those doing the most damage, however, were comparatively few in number. The end-rot of fruit (*Fusicoccum putrefaciens*), was found to do by far the most damage. In addition, *Phomopsis* species and *Sporonema oxycocci* do some damage.

During the growing season field rot of berries (*Sclerotinia oxycocci*) does some harm. This trouble is much like brown-rot in prunes. Fortunately it does not seem to do much damage after the vines get into good bearing.

According to Bain, Crowley, and other investigators, bordeaux mixture 4-4-50, applied at the right time, gives excellent control of all these fungous diseases, provided berries are picked dry or can be dried within a short time after picking. Fish-oil soap, at the rate of 2 pounds to 50 gallons, is usually added to the bordeaux as a spreader. Commercial powdered bordeaux mixed with a casein spreader has also been found satisfactory.

Two sprayings of bordeaux mixture, the first to be applied just before blooming, or what is known as the "hook" stage, and the second spray in the early part of July, just after two-thirds of the blossoms have fallen, will control the fruit end-rot, the Phomopsis, and the Sporonema. Sclerotinia oxycocci is controlled by bordeaux, applied when the ascospores appear in the spring in March or April, and supplemented by the two sprays put on for the control of the rots mentioned above. When it is realized that the loss from different rots on unsprayed berries held in local storage in the box may run as high as fifty percent if the berries are held until after Thanksgiving, and that this poor condition may be augmented when the berries are shipped out to the market, it is plain that spraying should be done in a most thorough manner to prevent these infections.

Rainy weather at picking time makes it almost certain that storage rots will appear with considerable severity even after spraying has been done. It is imperative, therefore, that berries be dried quickly after being picked in wet weather. More experimental work is needed in this field. In 1924 the loss from rot was very heavy, due to the rainy season at picking time. Because of rapid breaking down of the fruit during such seasons, the price is much lower than that paid for fruit known to be free from rot organisms.

Heavy sanding, advocated for certain of the cranberry insects, seems to cause a slightly heavier infection of cranberry diseases. This, however, can be partly overcome by the ordinary sprays of bordeaux mixture, so that the extra infection will be more than compensated for by the better control of insects.

Flooding to control such insects as the girdler and fire-worm, undoubtedly stimulates infection by rot, but, as has been pointed out, the benefits derived from this treatment are so great and infection can be controlled so well by spraying with bordeaux both before and after the flow that this procedure may be very profitable.

For a full discussion of cranberry diseases the reader is advised to obtain United States Department of Agriculture Farmers' Bulletin 1081, Cranberry Diseases and Their Control.[6]

SPRAYING METHODS

Portable spray outfits. The spray equipment for cranberry bogs will vary considerably with the size of the cranberry field. On small bogs with an especially firm bottom, a barrel-and-cart outfit holding fifty gallons of the spray mixture may be used. A hand pump provides the

pressure. In many places gasoline power outfits of considerable size and mounted on trucks are used for large areas. These outfits are taken along the roadways on the banks and dikes, and the mixture is forced through hose to the bogs, or through galvanized iron pipe used to distribute the liquid to different parts of the bog from which hose connections can be made for spraying. With a larger outfit the water-tank and mixing barrels are carried on a second truck behind the spray truck. On this trailer the bordeaux mixture is prepared by the man looking after the spray outfit and in this way little time needs to be lost in spray application. When the water-level is not more than twelve feet below the spray pump the water may be elevated through an injector and delivered into the spray tank and auxiliary tank. Spray nozzles having large liquid chambers and of the disk type, attached in batteries of 4 or 5 to a spraying rod, are very satisfactory for distributing the spray. Such an outfit should be able to maintain at least 250 to 300 pounds pressure at the pump. Under favorable conditions, one nozzle-man with this equipment will spray nearly one-half acre an hour.

For this method of spraying the average cost of labor and spray materials is between $5.00 and $6.00 an acre for each spraying.

Stationary spray outfits. In southwestern Washington most of the growers have stationary spraying plants. These consist of an engine of 4 to 5 horse-power, connected with a triplex pump and supplied with liquid from a spray tank holding from 200 to 500 gallons. The liquid is piped through galvanized iron pipe the diameter of which will depend upon the length of the lead. Usually one-inch pipe is employed where leads are not more than a thousand feet in length. Faucets are placed at convenient intervals along the pipe for hose connections. The spray gun is usually employed and from 1 to 2 guns can be supplied with a pressure of 250 to 300 pounds, depending upon the size of pumps and engine, length of pipe, etc.

WEEDS

The control of the different weeds which spring up in the cranberry bog is a serious matter. It is a continual fight to prevent the cranberry vines from being put out of commission. If previous to leveling the bog is flooded for a sufficiently long time to kill out all weeds, the problem of weed control is much simplified.

Low-growing plants, like moss, wild violet, sorrel, velvet-grass, and false dandelion will eventually be smothered out by cranberry plants if these can be kept free from weeds for the first few years by hand weeding. Winter flooding is effective against some upland annuals, such as false dandelions, sorrel, and velvet-grass. These are among the most serious weeds in Oregon. When bogs become too weedy the water is sometimes left on them until late in the spring, even up to the middle of May, in order to destroy weeds and weed seeds. This means that there will be no crop on the bog that year, but fruit buds will be formed for next year's crop. As yet summer flooding has never been tried to control weeds in Oregon, although this method is used in the eastern part of the United States.

Among the worst weeds are the grasses and sedges, both of which are best controlled by mowing. Other weeds, such as horsetail rush, Spanish bayonet, willows, alders, buck-brush, salal, and wild blackberry, must be pulled by hand or with weeding hooks. (Fig. 13.)

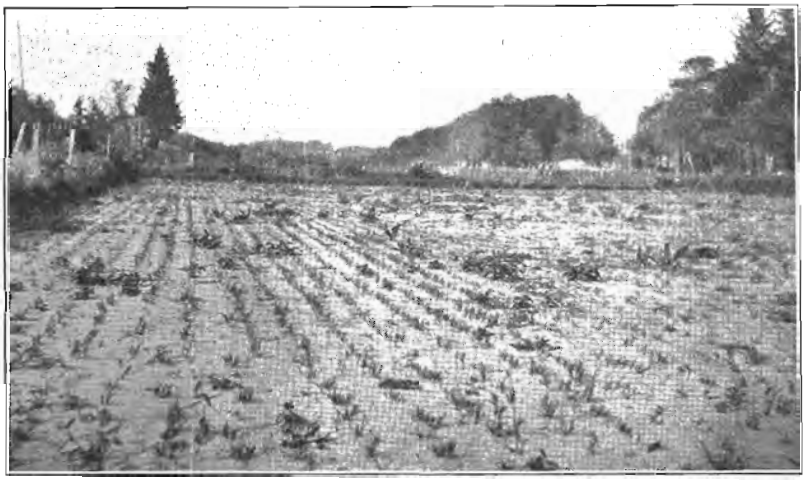


Fig. 13. The weed problem has appeared on this one-year-old bog.

Ferns and brakes sometimes become troublesome on a bog. There are chemical preparations made for killing them. In using these preparations the manufacturer's recommendations should be followed carefully. Sulfuric acid is sometimes used for this purpose also, but must be handled with extreme care in order not to poison the ground for the cranberries. About a teaspoonful of the acid of commercial strength is poured on the base of each fern, or in the center of the clump of stems. This can best be done by putting the acid in a squirt can equipped with a long spout.

Usually weeds flourish best when the water-table is rather high on the bog. For best results the water-table should be held about one foot below the surface of the bog. If possible, bogs in full bearing should be weeded before blossoming time.

FERTILIZERS

The peat soils on which the northwestern cranberries are planted need little if any fertilizer. When given good care the vines make an excellent growth. In fact the growth may become too vigorous in places and have to be cut back rather severely in pruning in order that scooping operations may not be hindered. If fertilizers are to be used, chemical fertilizers are preferable to manure, because barnyard manures are very apt to contain many weed seeds.

PRUNING

As a rule pruning is done in the late fall or winter on vines that are at least five years old. The purpose of the pruning is to thin out vines that have become so thick and tangled that fruit buds are not setting properly, and to straighten out the vines so that they can be scooped the following year. When the variety is picked by hand, as is often the case with the McFarlin, very little if any pruning may be needed. The operation is performed with a rake, such as an ordinary hand rake, fitted out with sharp, knife-like teeth. This rake is dragged through the vines, cutting off the ends of some of them and thinning out others. It is thought by many of the best growers that pruning has been too severe in the past. There is a pronounced tendency to lighten up this operation, both for the sake of the vigor of the vines and because larger crops are harvested when pruning is lighter. On the other hand heavy pruning causes less loss in scooping because it straightens out the vines and removes the snarls; it results in less loss by frost because it keeps down superabundant growth and allows sunlight to penetrate the vines better; it gives more even maturity of fruit because the sunlight is more evenly distributed.

Unless the prunings are to be used for setting new bogs they are taken to the dikes, where they are piled and burned. In some cases where the growth of vines is particularly rank, so that fruit buds are not produced in the dense shade, such vines may be cut back with a scythe or, what is even better, burned off in early spring. This will keep them from fruiting for a year or two, but will eventually bring on better yields. Frequently vines badly infested with insect pests are burned in early spring as they grow on the bog.

HARVESTING

The harvest season lasts from 6 to 8 weeks, depending upon weather conditions. It usually begins about September 10, and with a stormy autumn may extend into November.

Harvesting is done either by hand or with scoops. The equipment for hand picking is simple. The pickers have small, wooden boxes holding a peck when level full, and these boxes are emptied into a larger flat box with a slatted bottom for ventilation and holding four of the peck measures when less than level full. Strings are stretched across the bog, giving each picker a strip about three feet wide to cover thoroughly (Fig. 14).

Hand picking is the method generally used on all varieties which are not suitable for scooping. The McFarlin is the variety outstanding in this respect. Whenever this variety is scooped many of the berries remain on the ground after the scooping has been done. On the Washington bogs the McFarlin is usually scooped, while on the Oregon bogs it is most frequently picked by hand.

Women and children do much of the hand picking. They receive twenty-five cents a peck box, or $1.00 a bushel. Where the berries are plentiful good pickers can earn very fair wages at this rate, since it is not uncommon to pick five bushels by hand in a day.

For scooping, two types of scoops are used: the Cape Cod scoop, which originated in Massachusetts, and is used by the operator while on his knees, the scoop being swung very little; and the Wisconsin scoop,

Fig. 14. Hand picking of McFarlin cranberries.

equipped with a long handle, the operator standing on his feet and bending enough to swing the scoop into the vines. Scooping is done entirely by men as it is heavy, rather monotonous work. They are usually paid at the rate of 62½ cents an hour, or $5.00 for an eight-hour day. While it is impossible to harvest berries absolutely clean by this method, the

Fig. 15. Harvesting with the long handled or Wisconsin type scoop.

rapidity of picking more than makes up for the loss. Experiments have shown that it does not pay to pick up berries that have fallen to the ground. (Fig. 15.)

It is much better that cranberries should not be picked when the leaves are wet because of the danger of storage rot developing in light bruises made by picking. Rainy weather, however, sometimes makes it impossible to follow out this recommendation. The time of picking

Fig. 16. A delivery cart to bring cranberries to the dikes whence a truck or spring wagon takes them to the warehouse.

Fig. 17. The tramway is used on some bogs.

is determined by the color of the berries, some varieties coloring up more than others. The seeds of the berries should be a light brown color before picking. It is a characteristic of some varieties to color up considerably after picking, and this fact is taken advantage of by experienced growers.

It is estimated that a foreman with fifteen scoopers and two helpers to carry the boxes to the dikes or roadways, with another man to haul these in to the storehouse, has sufficient labor equipment for picking a fifteen-acre bog. Hauling the berries to the storehouse is usually done on automobile trucks or on spring wagons. Now and then some difficulty in traction is experienced with sand on the dike, but that is rather negligible. Another method is to build tramways on the dikes and load tram-cars with berries. The cars are then pushed into the storehouse by hand labor. Under most conditions the first method is the cheaper. Hauling charges will vary from 5c to 8c a box, depending upon the distance covered and the method used (Figs. 16, 17).

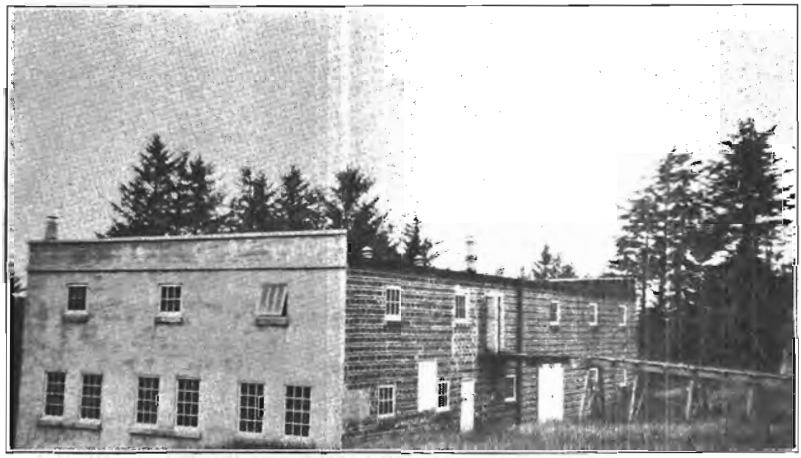


Fig. 18. An excellent storage and packing warehouse located on a railway spur not shown in the picture.

Yields. Most cranberry bogs are naturally rich in fertility. Fertilizers are seldom, if ever, used. Probably an average yield for good, bad, and indifferent bogs would amount to from 90 to 100 bushels per acre. This, however, is far below the possibilities of Oregon cranberry fields when given reasonably good care and protected from frost. Some bogs have averaged as high as 250 bushels per year for several years. Yields of 350 to 400 bushels per acre are not extraordinary, and in exceptional cases yields of 500 to even 600 bushels per acre on small acreages have been recorded.

The success of the cranberry industry in Oregon will depend more upon this one factor than upon any other. Cranberry growers in this state face many rather serious problems in the growing of the fruit and in marketing. Those that are succeeding best are the ones who are most carefully paying attention to the increase in their yields. The average yield in this state could undoubtedly be increased nearly double what it is at present.

Storage and packing houses. The prime objects to be held in mind in constructing these houses are arrangements for handling the fruit in an orderly manner and provisions for good ventilation. Cranberries are

stored in the bushel trays in which they come from the bog until such time as they are to be shipped out. Then they are screened and picked over. Where possible a very convenient arrangement for a storage house is to have the house located on a hillside so that the berries may be brought to the upper of two floors. There they are stored in trays. When they are to be shipped, they are run through mechanical graders to the lower floor, where they can be sorted by hand, packed, and loaded either into trucks or freight cars, depending upon the loading facilities. Such a storehouse should be constructed of materials which will give good insulation against fluctuating temperatures. Board walls, with dead air spaces, lined with building paper are used in the cheaper forms of construction, but for the better houses either well-seasoned, hollow concrete blocks or hollow tiles make the most durable and satisfactory con-

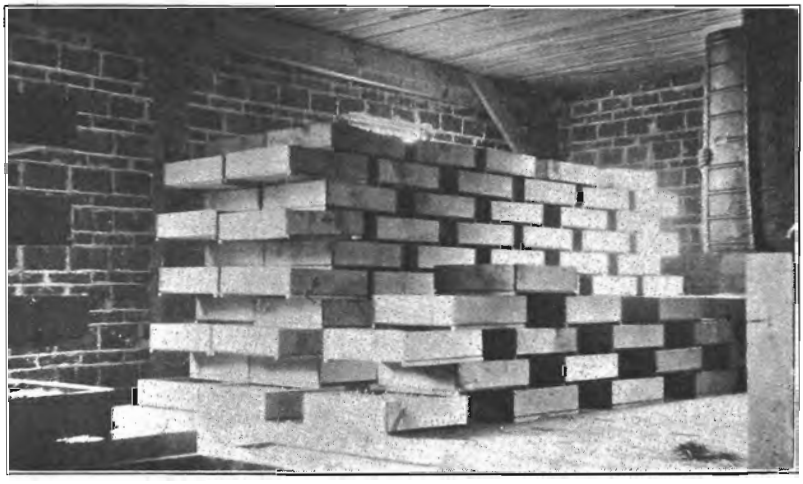


Fig. 19. Harvesting trays are "staggered" in the storage room to allow better ventilation.

struction material. If these blocks or tiles have their air spaces filled with sawdust or shavings, the insulation is still better.

A concrete block or a tile house, though quite expensive to build, is the best for community storing and packing enterprises (Fig. 18).

Very satisfactory results are obtained on individual bogs by a much cheaper construction with houses having only one floor, and so arranged that the berries are received at one end and passed from there through the grader to the sorting tables at the other end. They are then packed and ready for shipment. It is estimated that a house forty by seventy feet will accommodate the fruit from a ten-acre bog.

In all of these types of houses, ventilation must be carefully provided for in order to dry off moist berries just as rapidly as possible and to lower the temperature of fruit during the night. Doors and windows may be left open to provide a good draft of air. Boxes received from the field should be so stacked that there will be good circulation of air between all of them. (Fig. 19.) This is doubly necessary on the Pacific

Coast where the picking of berries when they are wet is sometimes absolutely unavoidable.

Preparation for market. Cranberries are left in the harvesting boxes until time for shipment. They are then graded by passing them over a machine having a hopper and equipped with a fan to blow out leaves and trash, and having also a series of inclined boards upon which the berries bounce. The firm berries, being more elastic, hop over into one compartment, while the soft berries go into another. The better berries then pass over screens, which sort them for size, and finally fall on moving belts where minor imperfections are picked out by hand. One of the most popular and common of these graders is the Hayden separator, made by the Hayden Separator Company of West Wareham, Mass. (Fig. 20).

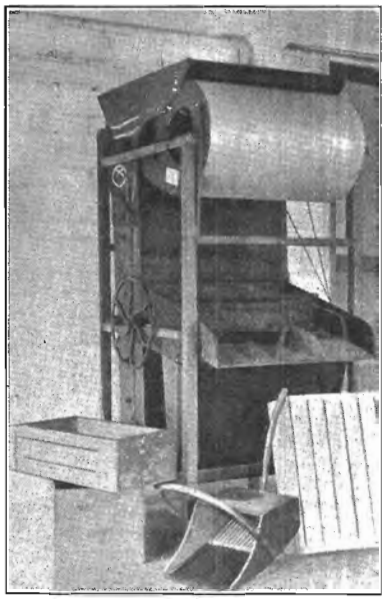


Fig. 20. The Hayden separator with Wisconsin scoop, flat picking tray, and two sizes of shipping boxes grouped around it.

Western berries are now being handled very largely in boxes holding $\frac{1}{3}$ of a cranberry barrel, or nearly a bushel, and measuring $7\frac{1}{2}$ x 12 x $21\frac{1}{2}$ inches inside measurement. On the end of the box is usually printed the grower's name and number and the name of the organization selling the berries. In packing, the berries are shaken down lightly, and heaped somewhat to insure a tight pack when the cover is put on. Slits in the side of the box provide ventilation. Boxes nailed together ready for packing will cost from 16c to 20c, depending upon the lumber market, prices of labor, etc.

Box cars are commonly used for shipping in moderate weather, but the refrigerator car must be used when shipments go into cold regions. Capacity loads are from four hundred to six hundred boxes per car, depending upon size of the car. Boxes are loaded tightly, end to end, in the car, spaces being left between sides of boxes for ventilation. Boxes are not usually piled more than half way to the ceiling of the car.

MARKETING

Practically all the cranberries grown in Clatsop county, Oregon, are usually sold through the Pacific Cranberry Exchange Cooperative. The headquarters of this Exchange is at Astoria, Oregon. The product goes through the ordinary channels of trade and is disposed of, for the most part, along the Pacific Coast from San Diego, California, to Alaskan points. Prices obtained by the Exchange have averaged from $8.00 to

$13.00 per barrel, depending upon the quality of the berries. The cost of producing cranberries is estimated by growers to vary from $5.00 to $9.00 a barrel, depending upon such factors as yields, costs of operation, overhead charges, etc. Cranberries grown in Coos county are sold through commission houses and help supply far-western markets. Undoubtedly the number of markets served by Pacific Coast cranberries can be increased as the product becomes better known through advertising.

Little has been done as yet to open up export markets. With improved cold storage facilities now found on fruit-carrying steamers, the physical obstacles to marketing abroad have been largely removed. Enterprising marketing organizations have an opportunity of widening the distribution of their product by building up a taste and a demand for the cranberry in foreign lands.

CONCLUSION

Success in the cranberry business depends on (a) the selection of a site where soil is suitable, where frost is not too great a menace, and where railroad facilities and marketing conditions are good; (b) carefully figuring the amount of capital needed to plant, equip, and manage a bog properly until it comes into profitable production; and (c) careful personal supervision. The last-named factor is probably the most important because cranberry growing is a highly specialized and intensive type of fruit farming, which may result in high profits or heavy losses, depending upon the management.

The acreage in Oregon suited to the production of cranberries has never been computed exactly, but it is considerable, as has been pointed out—most of it lying along the Coast.

The limiting factor in the development of the cranberry industry is not land, however, but is the competition which Pacific Coast cranberries will have to meet from cranberries grown in other parts of the country, and from other fruits in general. In view of the fact that cranberries are gradually being brought into more general use as an article of diet, that freight rates are high from the eastern part of the United States to the Pacific Coast, and that neither acreage nor tonnage of the cranberry crop has reached the percentage level of the population in the far western states, it would seem that there is justification for a moderate and gradual expansion of the industry on lands well-suited in quality and location.

The success of the cranberry business year after year will depend very largely upon (a) high yields of fruit of good varieties and of excellent quality; (b) grading this fruit carefully and putting it up in attractive packages; (c) advertising and distributing the product more systematically to the consuming public; and (d) the working together of all growers for the betterment of every phase of the industry.

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